

WHAT IS CLAIMED IS:

1 1. A method of charging and discharging a lithium secondary
2 battery which includes a negative electrode having an active
3 material layer including silicon provided on a current collector
4 comprising a metal which does not form an alloy with lithium,
5 comprising charging and discharging the battery within a range of
6 state of charge (SOC) where no peak corresponding to a compound of
7 silicon and lithium is observed in an X-ray diffraction pattern of
8 the negative electrode during charging using CuK_α -radiation as the
9 X-ray source.

1 2. The method according to claim 1, wherein the active
2 material layer comprises a thin film of amorphous silicon deposited
3 on the current collector.

1 3. The method according to claim 1, wherein no peak
2 corresponding to an intermetallic compound of lithium and silicon
3 is observed in the X-ray diffraction pattern.

1 4. The method according to claim 2, wherein no peak
2 corresponding to an intermetallic compound of lithium and silicon
3 is observed in the X-ray diffraction pattern.

1 5. The method according to claim 3, wherein the
2 intermetallic compound is $\text{Li}_{13}\text{Si}_4$.

1 6. The method according to claim 4, wherein the
2 intermetallic compound is $\text{Li}_{13}\text{Si}_4$.

1 7. The method according to claim 1, wherein no peak is
2 observed in the X-ray diffraction pattern in a range of $18 \sim 28^\circ$.

1 8. The method according to claim 2, wherein no peak is
2 observed in in the X-ray diffraction pattern a range of $18 \sim 28^\circ$.

1 9. The method according to claim 7, wherein no peak is
2 observed as a halo pattern in the X-ray diffraction pattern in a
3 range of $18 \sim 28^\circ$.

1 10. The method according to claim 8, wherein no peak is
2 observed as a halo pattern in the X-ray diffraction pattern in a
3 range of $18 \sim 28^\circ$.

1 11. The method according to claim 7, wherein no peak in the
2 form of three peaks is observed in the X-ray diffraction pattern in
3 a range of $18 \sim 28^\circ$.

12. The method according to claim 8, wherein no peak in the form of three peaks is observed in the X-ray diffraction pattern in a range of $18 \sim 28^\circ$.

13. The method according to claim 1, wherein the active material layer comprises silicon particles and a binder.

14. The method according to claim 1, wherein the active material layer is a thin silicon film formed by deposition.

15. The method according to claim 1, wherein the current collector comprises copper or a copper alloy.

16. The method according to claim 2, wherein the current collector comprises copper or a copper alloy.

17. A lithium secondary battery comprising a negative electrode having an active material layer including silicon provided on a current collector comprising a metal which does not form an alloy with lithium, wherein no peak corresponding to a compound of silicon and lithium is observed in an X-ray diffraction pattern of the negative electrode during charging using $\text{CuK}\alpha$ -radiation as the X-ray source.

1 18. The lithium secondary battery according to claim 17,
2 wherein the active material layer comprises a thin film of
3 amorphous silicon deposited on the current collector and no peak
4 except for a peak corresponding to the current collector is
5 observed in the X-ray diffraction pattern of the negative electrode
6 during charging using $\text{CuK}\alpha$ -radiation as the X-ray source.

1 19. A lithium secondary battery comprising a positive
2 electrode containing a positive electrode active material, a
3 negative electrode having an active material layer including
4 silicon provided on a current collector comprising a metal which
5 does not form an alloy with lithium, wherein an amount of the
6 positive electrode active material is an amount which limits the
7 charge capacity of the battery to 90 % or less of the maximum
8 capacity of the negative electrode.

1 20. The lithium secondary battery according to claim 19,
2 wherein the active material layer comprises a thin film of
3 amorphous silicon deposited on the current collector.